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have been tempted by the supposed exigencies of the physiological theory of sense-perception to adopt an epistemological dualism or representative theory of knowledge. Realism is not, however, bound up with dualism and might without the slightest inconvenience defend the common-sense view that perceptual consciousness extends to and reveals real objects outside the organism and is not confined to the comprehension of internal copies or ideas of these.

R. S. Woodworth,
Secretary.

Columbia University.

REVIEWS AND ABSTRACTS OF LITERATURE

The Afferent Nervous System from a New Aspect. Henry Head, W. H. R. Rivers and James Sherren. *Brain,* 1905, XXVIII. Pp. 99–115.

The Consequences of Injury to the Peripheral Nerves in Man. Henry Head and James Sherren. *Ibid.* Pp. 116–338.

These two articles are important to psychologists and should be read by all who are interested in the analysis of pressure and skin sensations. The material upon which the articles are based is a series of cases in which there was injury or division of some of the peripheral sensory nerves.

A sample observation which led to the research is as follows: "When the median nerve is divided, sensation is entirely lost over a considerable part of both index and middle fingers. Over the palm, within the area said by anatomists to be supplied by this nerve, sensation is usually diminished and not completely abolished. In a similar manner, division of the ulnar nerve produces complete insensibility of the little finger and of a variable portion of the ulnar aspect of the palm; but partial loss of sensation is found over a large area of the palm and the ulnar half of the ring finger. Such is the usual statement of surgeons and anatomists" (p. 100).

This statement of the results of injury led the authors to put to themselves two questions: 'What is meant by diminished sensibility?' and 'To what is it due?' Accounts of conditions in various forms of nerve lesions are given which indicate the answers to these questions. The diminished sensibility was found to be a true loss of certain sensations and the retention of others. Thus from careful study of the cases the authors have been able to differentiate some sensory elements which in normal people are with difficulty or not at all discriminated.

The experimental results are given from about eighty cases of injuries to the peripheral nerves, particularly to those of the hand and arm. Forty-six text figures illustrate the result, and there are eight excellent tables. The first article gives a general theoretical consideration of the results of all the work, and the second article is an account of the observations and experiments. We shall consider first the results of the experiments. In this article the work is divided as follows:

1. Nerve supply of the palm of the hand.
2. Recovery of sensation after injury to the nerves of the hand.
3. Recovery of sensation after incomplete division of the nerves of the hand.
4. Nerve supply of the forearm.
5. Injuries to the brachial plexus.
6. Loss of sensation in the arm from division of posterior nerve roots.
7. Nerve supply of the lower limb.
8. Deep sensibility.
9. Sensations of heat and cold.
10. The compass test.
11. Hair sensibility.
12. Hyperalgesia.
13. Changes in the skin that follow injury to peripheral nerves.
14. Changes in the nails after injury to peripheral nerves.
15. Paralysis and other muscular changes.
16. Theoretical.

Most of these sections have observations of interest to psychologists, but we shall consider only the main points.

If a mixed (sensory and motor) nerve supplying any portion of the body is cut, there is found to be a complete loss of all kinds of sensation from part of the region supplied by the nerve. Pain, pressure, light touch and temperatures are not felt, muscles can not be moved, and the positions of the parts are not appreciated. If, however, only the branches supplying the skin be divided, the muscular branches remaining intact, the muscles can be moved, movement properly sensed, and the part is sensitive to pressures. In such a case (pp. 214, 327), in which the radial and external cutaneous nerves were divided in the forearm, the authors found that all the movements of the hand and fingers were perfect, but "the skin over the back of the thumb and the radial half of the back of the hand were insensitive to light touch, to prick and to all forms of heat and cold. But over the whole of this area pressure was at once appreciated. . . . Touch with the blunt head of a pin was localized with remarkable accuracy, but our patient could not distinguish pressure with a head from a prick with a point of a pin, nor could he distinguish between pressures with a point of a pin and with a steel rod 2 c.m. in diameter (p. 327). Even when separated to 5 c.m. and applied transversely, the compasses were appreciated as a single 'push' or focus of pressure. Any stimulus dragged across the surface so as to move the skin over underlying parts was at once appreciated. . . . But if the skin was lifted the same method of stimulation entirely failed to evoke any response, a proof that whatever sensation had been previously present was due to the underlying structure." A number of cases which were observed demonstrate that the pressure sensations are carried by the nerves which supply the muscles, etc., and that these nerves accompany the tendons.

This condition, in which all forms of skin sensibility are lost, but pressures are appreciated, has been called *deep sensibility.* The conclusion which is psychologically important is 'that so long as the sensibility of the skin is unaffected, it is impossible to investigate the sensations evoked by pressure.' It is even difficult to determine with certainty the condition of the sense of passive position in the joints when superficial sensibility is present. The skin should be totally insensitive to all stimuli before deep sensibility can be satisfactorily tested, a condition which greatly limits the possible opportunity of examination.

Bounding such an area in which there is present only deep sensibility, there is a zone, of varying extent in individual cases, in which there is loss of sensory appreciation of light touch and of medium temperatures. Such sensibility has been called by the authors *protopathic.* In this area a prick may be so disagreeable that the patient withdraws his hand. "He complains that it causes a feeling of pins and needles, not only at the point pricked, but also widely over the intermediate zone. Asked to locate the spot pricked, he may be able to do so, but complains that the pain produced seems to him to be spread over a large surface, or even to be in two places at once, such as the base of the finger and the middle of the palm. Moreover, when tested with compasses, the points can not be distinguished as causing two sensations, even when separated from one another to the greatest extent possible within the intermediate zone." Water below 20° C. is felt as cold, but it makes no difference whether the water be 0° C. or 18° C. Above 45° C. or 50° C. water is felt as hot, but it is doubtful whether or not there is true heat sensation. The patients call the sensation hot or burning. Intermediate temperatures are not felt. In the normal area, of course, all forms of sense stimuli are appreciated. Those which are peculiar to the normal area are light touch, the appreciation of twoness, as for example in the double-point threshold, and the medium temperatures. This form of sensibility is given the name *epicritic.*

Occasionally patients were found in whom the area of loss of protopathic sensibility did not entirely cover the area of loss of deep sensibility. In such a case the skin is sensitive to light touches, but there is no appreciation of pressures as such. One instructive case of this character is that (p. 108) of a patient in whom an operation 'produced profound loss of sensation to prick over the one half of the face, unaccompanied by an equivalent loss of sensibility to light touch. Here there could be no doubt that the patient could appreciate warmth, but not heat, and he many times stated that a temperature of 55° C. was neither hot nor cold, but that 34° C. was undoubtedly warm.'

If a nerve which has been cut is sutured and the wound heals well, there is a gradual return of normal (epicritic and protopathic) sensibility to the anesthetic and partially anesthetic areas. First, the totally anesthetic area gradually grows smaller, and there is a return of the pressure sensation. The recovery begins in about ten weeks, and in about ten weeks later pressures may be felt over the whole area. Then there is a restoration of the sensibility to prick, to pain, to extremes of heat and cold. At this time the disagreeable radiating effects of the stimuli are present. Finally, the forms of epicritic sensibility begin to be felt in the area. The line of demarkation between the normal and abnormal is no longer well marked, and the area gradually grows smaller. Eventually, after two to four years, there is a complete return to normal function.

The characters of the lesions in most of the cases which appear at the hospitals are such that the results are not simple. Moreover the patients are not good observers. Experiments must be made of the conditions as they are, not as one would like to have them. The authors felt the necessity, therefore, of a carefuly localized lesion and of a skilled observer for the determinations of the sensory changes. For this reason one of them (Head) had his radial and external cutaneous nerves divided near the elbow to be able to compare the normal sensitivity and the sensory changes following the operation. The results of this experiment—which was most painful and not without considerable danger—are given in part in the present article, but a fuller account is promised. We shall await with much interest the complete report of this work. "The knowledge of the properties of deep sensibility gained from this experiment," it is said (p. 282), "enabled us to understand the full significance of the various forms of residual sensation discovered after division of peripheral nerves." The promise is made that 'in a subsequent paper it will be shown that, so far as protopathic sensibility is concerned, at least three end organs exist and each of these reacts only to a specific stimulus.'

The conclusions which seem justified from the experimental results are as follows (pp. 111, 114, 298): The sensory mechanism in the peripheral nerves is thus found to consist of three systems:[1]

1. "Deep sensibility, capable of answering to pressure and to the movement of parts, and even capable of producing pain under the influence of excessive pressure, or when the joint is injured. The fibers, subserving this form of sensation, run mainly with the motor nerves, and are not destroyed by division of all the sensory nerves to the skin."

II. "Protopathic sensibility, capable of responding to painful cutaneous stimuli and to the extremes of heat and cold." "It also endows the hairs with the power of reacting to painful stimulation." "This is the great reflex system, producing a rapid, widely diffused response, unaccompanied by any definite appreciation of the locality of the spot stimulated." "These fibers regenerate rapidly after the ends of the nerves have been reunited; if the operation has been successfully performed sensation begins to return within from seven to ten weeks. In any peripheral nerve the distribution of the protopathic fibers usually overlaps greatly the area supplied by the fibers of the adjacent nerves."

III. "Epicritic sensibility, by which we gain the power of cutaneous localization, of the discrimination of two points, and of the finer grades of temperature, called cool and warm." "These fibers regenerate more slowly than those which subserve protopathic sensibility after reunion of a divided nerve, and sensation does not usually begin to return in less than six months under the most favorable conditions. The distribution of these fibers in the larger peripheral nerves, such as the median and ulnar, overlaps little compared with a great overlapping of the protopathic supply." "As soon as a sensory impulse reaches its first junction in the spinal cord, it becomes shunted into tracts devoted to the conduction of impulses grouped in a way different from that found in the peripheral nerves. It is no longer a question of protopathic, epicritic or deep sensibility; the tracts in the central nervous system are devoted to the conduction of impulses concerned with pain, heat, cold and touch."

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[1] These excerpts are taken from both papers, and as here given do not conform in every instance to the sequence in which they originally occur.

"The system we have called protopathic in the skin is one with the afferent fibers of the sympathetic as they supply the viscera. In both cases the sensation is badly localized, radiates widely and is frequently referred to parts other than those stimulated. . . . The whole body within and without is supplied by the protopathic system. The fibers of this system in the skin may be spoken of as somatic, those to the internal organs as visceral protopathic fibers. . . . Another set of afferent fibers peculiarly associated with impulses of movement and pressure exist in connection with the Pacinian organs. In the body and limbs, an analogous system is found peculiarly susceptible to pressure, to the localization of movement and to the appreciation of position. The fibers of this system run in conjunction with the motor nerves. In addition to these two systems, which are distributed to all parts of the body within and without, the surface of the body only is supplied by a third system, which we have called epicritic."

This work illustrates well the value of a study of the abnormal for the understanding of normal processes. Not only is normal psychology of value for the understanding of the abnormal, but pathological or abnormal psychology can give new points of view to the student of normal mental life. It is safe to say that the work of Head and his collaborators is the most important contribution to the study of skin and pressure sensation which has appeared in many years.

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The Experience Philosophy. WARNER FITE. *Philosophical Review,* January, 1906. Pp. 1–16.

Professor Fite is convinced that a fundamental fallacy underlies all 'experience-philosophy,' by which term he means any philosophy based exclusively on experience and declaring that the object of consciousness has no real existence apart from its presence in consciousness. His critique is directed, first, against the assumption of the series of experiences as *real* and, second, against the *reality* of the present experience.

The series of experiences, although taken only as a working basis, must still involve a belief that the past fact of experience is in some